THE REPAIR OF FARM EQUIPMENT.—II.*

IDEAS FOR THE HANDY FARMER.

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MISCELLANEOUS TOOLS.

THERE are a number of tools adapted to the handling of both wood and metals required in general repair work about the farm.

Tinners' Snips.—A small pair of tinners' snips, or shears, is desirable for cutting all kinds of sheet metals that may be required either for repair or construction work. The size of these shears is determined by the length of their jaws in inches. A 2½ or 3-inch size is desirable and should cost between \$1 and \$1.50.

Small Vise.—A small bench or table vise having about a 2½-inch jaw is useful for many purposes, especially where the objects to be held are quite small. This tool is also desirable for mending harness in case a regular harness clamp is not available. A vise of this character will cost all the way from 50 cents to \$1.50, according to size and quality.

Dividers.—The little implement known as dividers, or compasses, is desirable for drawing circles or segments of circles in the making of special parts of machinery from wood. The cost of a pair of dividers with a segment and set-screw for setting to any angle should not be more than 60 cents.

Pliers.—Some form of pliers for working wire is essential. Besides their use for handling wire a good pair of pliers is desirable for a great many lines of repair work. There are a number of styles of pliers on the market, but one of the simpler types (Fig. 18) will give the greatest amount of service. As a rule a very serviceable pair of pliers can be secured for about 60 cents.

Cutting Nippers.—A pair of heavy cutting nippers with circular jaws is useful for many purposes, especially for removing a shoe from the foot of a horse or for trimming the edge of a broken hoof. Where a horseshoeing outfit is maintained, the cutting nippers will be included.

A Crowbar or Pinch Bar.—A crowbar or pinch bar will be found useful on the farm for prying or moving heavy objects. Where stones are to be removed from the soil a bar of this character is almost indispensable. A bar for general purposes weighing about 20 pounds will cost from \$1 to \$1.50.

Maul, or Beetle.—A maul, or beetle, can be hewn from a gnarly piece of hickory or gum. The head portion of the maul should be about 9 inches in length and 6 or 7 inches in diameter. Through the middle of this block a hole about 1½ inches in diameter is bored and a shaved hickory handle inserted, forming a mallet weighing 16 to 25 pounds. If extra-heavy work is to be done, the head can be reinforced by means of iron rings, which are put on while hot and shrunk into place. This tool is desirable for driving heavy stakes and similar work.

Grindstone.—The farm repair outfit will not be complete unless some form of grindstone is included. The old type of stone with its wooden shaft, crank, and bearings has largely been replaced by the light-

FIG. 18.—PLIERS.

running treadle grindstones. No part of the repair work is so important as the keeping of tools in good order, and proper facilities for sharpening are essential. A good stone, mounted ready for use, will cost about \$3.50.

Oilstone.—The oilstone is a necessary adjunct to the grindstone, its use being to put a smooth edge on the tools after grinding. Chisels, the bits of planes, and similar tools require grinding only occasionally, but may be sharpened quite frequently on the oilstone, and a fine cutting edge maintained. Instead of water, use kerosene or any light oil on the oilstone and wipe off clean when through sharpening. Oilstones can be bought at prices from 60 cents to \$1.

Oiler, or Squirt Can.—This device is a convenience

about the shop, both for oiling machinery and for keeping tools in order. A small oiler is desirable for use in connection with the oilstone. A can of this character will cost from 10 to 40 cents, according to quality. In purchasing an oiler care should be taken to secure one having a folded seam where the bottom is joined to the main portion, as a soldered seam is liable to give out in a short while. It is also essential that the bottom should have plenty of "spring" to force the oil from the spout.

Wire Stretcher.—On farms where wire fencing is

FIG. 19.—RIVET SET.

employed it will be necessary to provide an appliance for stretching lines of wire. For light work, where short runs of single wire are to be handled, one of the hand-lever stretchers will be found most satisfactory. This tool consists of a wood lever about three feet in length, about one-third the distance from one end of which is attached a pair of grips or pliers to hold the wire. The wire is gripped in the holder, the short end of the lever passed around the post, and the power applied to the handle. A stretcher of this type can be purchased for about 75 cents.

Another form of stretcher consists of a wire grip to which is attached a ring through which an ordinary crowbar may be passed to serve as a lever. This type of grip is obtainable for about 50 cents.

ple by means of a hammer, then by a prying movement the staple is easily drawn. The handle end of the clawbar (Fig. 4) may be shaped for use in drawing staples.

HARNESS-REPAIR OUTFIT.

The tools and facilities required for keeping harness in repair are comparatively simple and inexpensive. Many of the parts of harness, together with convenient supplies with which to make repairs, are now offered at reasonable prices by dealers everywhere. A considerable portion of the repair work on harness can be performed by the aid of tools required for other purposes, but there are a few special devices that are desirable.

Leather Punch.—A good leather punch is one of the most desirable implements both for repair work and for making alterations in harness to fit animals of different sizes. A leather punch made somewhat on the order of a pair of pliers and having four or more punching tubes of various sizes is most desirable. It can be secured for about 40 cents.

Rivet Set.—A rivet set is especially desirable for use in connection with solid copper or coppered steel rivets. This (Fig. 19) is made of a small piece of tool steel and is provided with a small hole for driving down the washer on the rivet, also a countersink for expanding the end of the rivet.

Riveting Machines.—There are upon the market several kinds of lever devices for use in the insertion of hollow or tubular rivets in leather. These riveting machines are comparatively cheap, but as a rule the hollow rivets do not hold so well as the solid rivets.

Awls.—For the repair of driving harness there should be kept on hand one or two awls to be used in making the holes for sewing with a waxed thread. Awls of this character can be purchased for about 10 cents each, including handle.

Harness Clamp.—A clamp of some character is desirable for holding parts of harness while repairs are being made upon them. For this purpose a small table vise may be employed or a regular steel or wooden clamp may be purchased. A very serviceable home-made clamp may be constructed from two pieces of wood shaped somewhat like the staves of a barrel; at one end these pieces are dressed off so that they will fit together like the jaws of a vise, and the opposite ends may be hinged together or they may be fastened

FIG. 20.—CROSS-SECTION OF WORKBENCH.

A, planing stop; B, bench screw.

Staple Puller.—A staple puller is essential to the repair or alteration of wire fencing. An old mower guard will serve for this purpose, but a more satisfactory device may be constructed from a piece of ¾-inch steel rod, about 15 inches in length, by drawing one end to a point, then turning about 1½ inches of this point at a right angle to the main portion. In using this tool the point is driven behind the sta-

firmly to the sides of a base block. A short distance from the clamping end a screw, a bolt, a leather strap, or some other simple device may be used to draw the jaws tightly together.

SPECIAL CONVENIENCES.

In addition to the outfit of tools obtainable from a hardware dealer, there are a number of special devices that may be made on the farm and which will prove

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of great assistance in general repair work. Among the more important are the following:

Workbench.—A workbench of some kind will probably be the first essential. A good type of workbench is shown in the foreground of Fig. 21; also in cross section in Fig. 20. For the construction of this bench there will be required four boards seven-eighths inch thick, 12 to 14 inches wide, and about 12 feet in length. The length of the bench, however, will depend upon the size of the shop or other space that may be available for use as a workroom. Two pieces of 2 by 4 inch scantling, each 16 feet long, will be sufficient to construct the framework of the bench. All lumber entering into the construction of the workbench should be thoroughly seasoned and dressed to uniform width and thickness.

A clamp for holding materials should be constructed from a piece of hard wood and attached by the aid of a carpenter's bench screw, as shown in cross section in Fig. 20. This clamp should be provided with notches or pin holes at the lower end, so that it can be set to hold materials of any thickness. Along the front of the bench, two or three holes should be provided, into which pins may be set for supporting boards or other materials that are too long to be held rigid by the clamp alone.

A "stop" for holding materials that are to be planed can be inserted in the top of the bench, near the left-hand end, as shown in Fig. 20. If a regular stop is not employed, its place may be taken by a small piece of notched board nailed on top of the bench.

Sawhorses.—A pair of trestles, or sawhorses, each consisting of a piece of 2 by 4-inch or 2 by 6-inch timber, about 4 feet in length, supported upon four legs, as illustrated in the foreground of Fig. 21, are very convenient for working upon while marking, sawing, boring, or chiseling. The sawhorses are an accessory to the workbench and should be constructed at the same time. The cost of materials with which to construct both the workbench and sawhorses should not exceed \$5.

Miter Box.—Among the accessories to the workbench there is perhaps no device that will give greater satisfaction than a good miter box to be used for sawing small wood materials either square or at an angle. For the construction of a miter box, three pieces of board 1 inch thick, 6 inches wide, and 3 feet in length should be selected and nailed together in the form of a square trough, taking care that the nails are driven well out toward the edge of the boards. Vertical cuts are sawed down through the sides to the bottom board to guide the saw when the box is in use. Near one end a cut is made at right angles with the length of the box to be used in making square cuts. For making bevel cuts for a right-angled miter joint, the sides of the box should be sawed down on oblique lines running at an angle of 45 degrees with the length of the box. Two such cuts should be made and should cross each other at the middle of the box, forming a letter X. In marking the box to make these cuts, the square should be laid flat on top of the box so that its corner is flush with the outer edge on one side, and each arm reaching obliquely across the box will show exactly the same number of inches to the outer edge on the

eral-purpose repair tools the better grades have been placed in the higher priced sets, although those included in the cheaper outfits should be of good and durable material.

A \$2.50 Outfit.—A hatchet, a handsaw, a small square, a screwdriver, and a pair of pliers.

A \$5 Outfit.—A hatchet, a 26-inch handsaw, a small steel square, a drawing knife, a brace and four bits ($\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, and 1 inch), a pair of pliers, a screw-

a bevel square, a scratch gage, a pair of dividers, a small try square, a scratch awl, 2 twist drills ($\frac{1}{2}$ and $\frac{3}{4}$ inch), an oilstone, and a pair of soldering irons.

A \$25 Outfit.—To the list given for the \$20 outfit add the following: A small steel square, an alligator wrench, a hack saw, a 10-inch pipe wrench, a pair of tinners' shears, a ratchet brace instead of a plain brace, a rivet set, additional bits to make a full set of 12 ($\frac{1}{4}$ inch to $1\frac{1}{4}$ inches by eighths and sixteenths),

FIG. 22.—FLOOR PLAN OF WORKSHOP.

driver, a cold chisel, a flat file, and a monkey wrench.

A \$10 Outfit.—A hatchet, a hand ax, a 26-inch handsaw, a 24-inch steel square, a drawing knife, a brace and six bits ($\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, and 1 inch), a pair of pliers, a screwdriver, a cold chisel, a 12-inch flat file, a monkey wrench, a jack plane, 2 chisels ($\frac{1}{2}$ and 1

and a smoothing plane. A \$25 outfit is shown in Fig. 21.

IRON-WORKING AND SHOP EQUIPMENT.

Blacksmithing Tools.—A blacksmith's outfit adapted to the requirements of a large farm should include a forge, an anvil, a 2-pound hammer, an 8-pound sledge, a riveting hammer, two pairs of tongs, an assortment of punches, hot and cold chisels, anvil hardie, cutting nippers, coarse files, screw plate, vise, drill press with drills, and a monkey wrench. The cost of this outfit may be as low as \$30 or as high as \$60 and upward, according to the class of materials selected. "Combination outfits" consisting of the above tools are offered at these prices, but if the outfit is made up by selecting from the general stock of a dealer, the price paid will be much greater.

Shop Equipment.—The complete equipment of a shop for the making of general farm repairs should include the above blacksmithing outfit, the \$25 collection of wood-working and general-purpose tools, a pipe-working combination, miscellaneous tools, harness-repair outfit, a workbench, a pair of sawhorses, and a grindstone. This entire equipment for a shop can be secured for about \$100 in a fair quality of goods, and for \$150 tools of excellent quality can be obtained.

SHOP FACILITIES FOR REPAIR WORK.

A shop or other suitable place where repair work can be carried on during cold or stormy weather is almost as important as the tools and materials with which to make the repairs. A small building devoted exclusively to shop purposes is desirable, but where this is not available a portion of one of the regular farm buildings may be utilized. One side of a wagon shed can frequently be devoted to this purpose. A workbench can be fitted up and provision made for the care of tools and supplies.

Plan of Workshop.—A shop which meets the requirements of the general farm is illustrated by the floor plan shown in Fig. 22. The shop from which this plan was taken consists of a one-story building about 24 feet in length and 16 feet in width, having a plank floor over about two-thirds of its area, the remainder with an earth floor being used as a blacksmith shop. The floored portion was provided on the one side with a wood-working bench, over which were placed several shelves for the reception of tools. On the opposite side there was provided a heavy plank bench with a vise and other equipment for working iron. Below the iron-working bench there should be provided a rack upon which to store the stock of various sizes of square and round iron required for making repairs. Above the iron-working bench there should be a few shelves for the storage of tools; also numerous pigeon-hole boxes for the accommodation of the stock of bolts, nuts, and washers.

This shop was constructed of cheap lumber, the siding being put on up and down with cracks battened, and it has a simple gable roof. By this type of construction ample space is secured overhead for the storage of materials, especially seasoned timber for use in making repairs. An abundance of light is essential to good work, and as much of the repair work will be done during dark and cloudy weather, the windows should be numerous and so distributed as to provide for uniform lighting. The windows should be protected on the inside by wire netting.

The large doors in the end of the shop are made to cover the entire space between the workbenches, so that the larger farm implements may be brought upon the floor for repairing. Where the climate is cold, provision should be made for a heating stove, in order that the shop may be comfortable for work during winter weather. If a portion of a wagon shed or other

FIG. 23.—BOLTS.

A, Carriage bolt; B, machine bolt.

inch), a rivet punch, a riveting hammer, a leather punch, and a small oil can.

A \$15 Outfit.—An ax with handle, a hand ax, a hatchet, a 26-inch handsaw, a 24-inch steel square, a drawing knife, a brace and six bits ($\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, and 1 inch), 3 twist drills ($\frac{3}{16}$, $\frac{1}{4}$, and $\frac{3}{8}$ inch, with square shank to fit in carpenter's brace), a bit gimlet,

FIG. 21.—INTERIOR OF WORKSHOP WITH \$25 OUTFIT OF TOOLS, A WORKBENCH, SAWHORSES, AND MITER BOX.

other side. When the square has been correctly placed, mark along one arm for one of the cuts; then reverse the position of the square and mark for the other cut. A miter box is shown on top of the workbench in Fig. 21.

COMBINATION TOOL OUTFITS.

For the benefit of those contemplating the purchase of tools for use on the farm the following combinations are suggested. In making up these lists of gen-

a screwdriver, a jack plane, a pair of pliers, 2 chisels ($\frac{1}{2}$ and 1 inch), an auger ($1\frac{1}{2}$ inch, with handle), a small vise, a cold chisel, a monkey wrench, a rivet punch, a claw hammer, a riveting hammer, a leather punch, a compass saw, a spirit level, an oil can, a 12-inch flat file, a 12-inch wood rasp, 2 small three-cornered files, a 2-foot folding rule, a chalk line, and a ball of chalk.

A \$20 Outfit.—To the list given for the \$15 outfit, add the following: A 26-inch ripping saw, a spokeshave,

farm building is set aside for shop work, it should, so far as practicable, be fitted as a regular shop.

The Care of Tools.—The system of storing the tools should conform to the needs of those using them and to the work to be performed. In many instances it may be desirable to keep the tools in a portable chest in which they may be carried to any part of the farm or plantation; on the other hand, if the work is done almost entirely at the shop the tools will be more accessible when supported on the walls or upon shelves above the bench.

In climates where the atmosphere is moist the greater part of the time, it is not wise to keep the tools exposed by hanging them on the walls or laying them upon open shelves, but a wall cabinet or a tool chest should be provided. It should be the aim to have a place for every tool, and then cultivate the practice of returning it to its proper place immediately upon the completion of the work in hand. A very good plan for keeping the tools in their respective places is to first draw an outline of each tool in its place upon the wall and then paint this space black or some color in contrast with the wall itself, so that when any tool is not in its place its absence will be readily apparent.

Many persons are in the habit of leaving tools where they finish using them. In the first place, a tool can not be kept in working condition if allowed to remain exposed to the weather, and in the second place the time lost in locating the tool when it is next required for use will be much greater than that which would be required to return it to the proper place.

MATERIALS REQUIRED FOR GENERAL REPAIR WORK.

However complete the tool equipment, it will be of little use without a supply of materials with which to replace worn or broken parts of machinery and implements. The time required to secure stock materials may be as great as that necessary to have the repairs made in the nearest shop. A supply of timber, bar iron, bolts, rivets, screws, etc., should be kept constantly on hand and renewed from time to time as the stock runs low.

WOOD MATERIALS FOR REPAIRING FARM EQUIPMENT.

The supply of wood for use in making repairs should be well seasoned and dry. It should include split hickory, ash, and oak, from which handles, single-trees, double-trees, neck yokes, and similar articles can be made. Split timber is better than sawed for these purposes, owing to the straight grain when the wood is split. Sawed oak, ash, or heart pine, in sizes 1 by 2, 2 by 4, 2 by 6, 3 by 4, 3 by 6, 4 by 4, and 4 by 6 inches, and 14 or 16 feet in length is frequently required for use in replacing broken handles, braces, tongues, axles, etc. It is also desirable to have on hand a small stock of white pine, one-half and seven-eighths inch in thickness, for use in repairing or replacing the lighter wood parts of implements.

A great variety of wooden parts for farm implements is kept in hardware and general supply houses. On large farms it is advisable to keep on hand one or two each of the following: Ax handles, hatchet and hammer handles, hoe and rake handles, fork handles, shovel handles, single-trees and double-trees, wagon tongues, carriage poles, and buggy and wagon shafts.

It should be the practice to save every small piece of good material and store it in a dry loft or other convenient place. A good piece of a thin board can frequently be saved from a broken packing box, and this will serve as well as new material for repair work. It should be the policy to save every good barrel hoop or extra barrel head for future use in replacing a broken or missing one. Very little time will be required to care for these articles if some system of storing them is employed.

METAL MATERIALS FOR REPAIRING FARM EQUIPMENT.

Bar Iron.

Where a regular blacksmith outfit is maintained the supplies kept on hand should include a stock of both round and square iron. The bars come in lengths of about 14 feet.

Round Iron Bars.—The stock should include the following: $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, and $\frac{3}{4}$ inch, three to five bars each, and one bar 1 inch in diameter. The $\frac{3}{8}$ and $\frac{1}{2}$ inch sizes are most frequently needed.

Rectangular Iron Bars.—The stock should include the following sizes: $\frac{1}{2}$ by $\frac{3}{4}$ inch, $\frac{1}{2}$ by 1, $\frac{1}{4}$ by 1, $\frac{1}{4}$ by 2, $\frac{3}{8}$ by 1, $\frac{3}{8}$ by $1\frac{1}{2}$, $\frac{3}{8}$ by 2, $\frac{1}{2}$ by 1, $\frac{1}{2}$ by $1\frac{1}{2}$, $\frac{1}{2}$ by 2, and $\frac{1}{2}$ by 3 inches. The greatest demand will be for $\frac{1}{4}$ by 1 inch, $\frac{1}{4}$ by 2, $\frac{3}{8}$ by $1\frac{1}{2}$, and $\frac{1}{2}$ by 2 inches, and of these sizes three or four bars should be secured. Of the other sizes one or two bars will usually suffice.

T-Bars and Angle Iron.—These in sizes up to $2\frac{1}{2}$ inches are very useful for making repairs on harrows, cultivators, and other implements in the construction of which such iron has been used.

The price of bar iron varies with the market, but it is usually less than \$3 per hundredweight.

Iron Bolts.

For the convenience of intending purchasers, a list of bolts is given. The sizes most needed in repair

work are indicated by the larger numbers suggested. For information concerning prices, dealers or their catalogues should be consulted, as the prices vary with locality and market conditions. Bolts, screws, and rivets can be secured at a great reduction if purchased in original packages containing 50 or 100, or a gross, as the case may be.

Carriage Bolts.—As a rule the round-headed or carriage type of bolt is best adapted for use in wood or where wood and iron are bolted together. Whenever a nut is being drawn down upon wood, a washer should be placed beneath it. A hole bored for the insertion of a carriage bolt should not be more than one-sixteenth inch larger than the bolt, as the square shank of the bolt should be driven solidly into the wood to prevent its turning. The difference between machine and carriage bolts is shown in Fig. 23.

The supply of carriage bolts should include the following: 100 each of $\frac{1}{4}$ by 2, $\frac{1}{4}$ by 3, and $\frac{1}{4}$ by 4 inches; $\frac{3}{8}$ by 2, $\frac{3}{8}$ by 3, $\frac{3}{8}$ by 4, and $\frac{3}{8}$ by 6 inches; $\frac{1}{2}$ by $1\frac{1}{2}$, $\frac{1}{2}$ by 2, $\frac{1}{2}$ by 4, and $\frac{1}{2}$ by 6. Of the following sizes a dozen each should be secured: $\frac{1}{2}$ by 8, $\frac{1}{2}$ by 10, and $\frac{1}{2}$ by 12 inches.

Machine Bolts.—These have square heads but the shanks are round throughout. For bolting together iron parts, they should always be used. The following will make a fair supply for a farm: 100 each of $\frac{3}{8}$ by 2 and $\frac{3}{8}$ by 4 inches; $\frac{1}{2}$ by $1\frac{1}{2}$, $\frac{1}{2}$ by 2, $\frac{1}{2}$ by 3, $\frac{1}{2}$ by 4, and $\frac{1}{2}$ by 6 inches; $\frac{3}{4}$ by 2 and $\frac{3}{4}$ by 4 inches. A dozen each of the following should be included: $\frac{1}{2}$ by 8 and $\frac{1}{2}$ by 10 inches; $\frac{3}{8}$ by 6, $\frac{3}{8}$ by 8, and $\frac{3}{8}$ by 10 inches; $\frac{3}{4}$ by 3, $\frac{3}{4}$ by 4, $\frac{3}{4}$ by 5, $\frac{3}{4}$ by 6, $\frac{3}{4}$ by 8, $\frac{3}{4}$ by 10, $\frac{3}{4}$ by 12, and $\frac{3}{4}$ by 14 inches.

Tire Bolts.—Bolts either $\frac{3}{16}$ or $\frac{1}{4}$ inch in diameter and from $1\frac{1}{2}$ to 2 inches in length are most used. Examine the wheels of the vehicles which are to be kept in repair, and get two or three dozen of each size of bolts needed. A few felly plates should be included.

Extra Nuts.—To replace lost nuts, the following should be included in the stock: 25 each of $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, and $\frac{3}{4}$ inch sizes.

Washers.—For use with bolts and rivets, get 2 pounds each of the $\frac{1}{4}$ and $\frac{3}{8}$ inch sizes, and 5 pounds each of the $\frac{1}{2}$ and $\frac{3}{4}$ inch sizes.

Rivets, Screws, Nails, Etc.

Iron Rivets.—For most purposes rivets with small round heads or with broader flat heads are used. The sizes most needed are $\frac{3}{16}$ and $\frac{1}{4}$ inch in diameter and $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$, and 1 inch in length. From a half pound to a pound of each size will be an ample supply. Rivets with countersunk heads are used for some purposes, and a few of the different sizes should be secured; also a few of the special rivets used in repairing mower and reaper knives.

Wood Screws.—Screws are classified by number and length, the number referring to the diameter. They are put up in boxes each containing one gross. A gross each of the following sizes should cost about \$2, and will meet all ordinary demands: No. 6, of $\frac{3}{4}$ and 1 inch lengths; No. 8, of 1, $1\frac{1}{4}$, and $1\frac{1}{2}$ inch lengths; No. 10, of $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$, and 2 inch lengths; and No. 12, of 2 and $2\frac{1}{2}$ inch lengths.

Nails.—Of flat-head wire nails, 5 pounds each of 3, 4, 5, and 6-penny sizes and one keg (100 pounds) each of 8, 10, 20, and 40-penny sizes should be obtained. Nails purchased in small quantities will cost 4 and 5 cents a pound, but if secured by the keg the cost is generally below 3 cents a pound. For certain purposes, such as the laying of floors and the construction of partitions from matched lumber, the square cut steel nails are considered desirable. Wire brads of various sizes and lengths are useful for both repair and construction work, and a few of these of different sizes should be secured.

Staples.—Of the standard size used in the construction and repair of wire fencing, 10 pounds or more should be kept on hand; also a pound or two of the smaller sizes for fastening poultry netting. Small staples, known as "double-pointed tacks," are useful for tacking fly screen over windows and for many other purposes.

Strap Hinges, Clips, Wire, Tin, Etc.—On farms that are at a distance from a hardware store, a few pairs of strap hinges of 3, 4, 6, 8, 10, and 12-inch lengths should be kept in stock. Hooks and staples or iron latches for fastening gates and barn doors may also be included in the hardware list. Clips for single-trees, double-trees, and neck yokes are offered by dealers at prices far below the cost of having them made at a local shop. Other materials that may often prove useful are small copper wire, annealed wire, galvanized wire, hoop iron, galvanized sheet iron, and sheet tin.

SUPPLIES FOR REPAIR OF HARNESS, CARRIAGE TOPS, ETC.

Every farmer should have on hand supplies for the repair of harness, and many will find it an advantage to have also some materials for making the simpler repairs on carriage and buggy tops. Ready-made harness and bridle parts of all kinds can be secured from many of the larger establishments.

Harness Rivets.—The solid rivets for harness repairs are either of copper or coppered steel, the former costing about three times as much as the latter. They

can be bought in boxes containing assorted lengths ranging from one-fourth to three-fourths inch.

Leather.—By visiting a regular harness shop, it is often possible to secure at a small cost scraps of harness leather that will prove very useful in making repairs; but where the amount of repairing to be done is large, the purchase of a whole side of good harness leather is advisable.

Harness Hardware.—The supplies of this class most often required are buckles of various sizes, snap hooks, bridle bits, hame staples, hame clips, cockeyes, open links, and rings of different sizes.

Other Materials.—The outfit should also include thread, beeswax, extra awls and needles, carriage washers, knobs, and eyelets for carriage curtains, shaft tips, and harness oil. A broken shaft may often be made good with a metallic shaft end. There are also on the market a number of devices, known as "menders," for making quick temporary repairs to harness.

PAINTS, OILS, AND MISCELLANEOUS SUPPLIES.

For repainting the farm equipment the following supplies will be found useful: White lead, red lead, Venetian red, raw linseed oil, and turpentine. Ready-mixed paints can be used, but when made of good materials they are more expensive. For lubrication purposes there should be a supply of machine oil, axle grease, and castor oil. For miscellaneous purposes there will be required small quantities of liquid glue, rubber cement, solder, soldering fluid (prepared by adding metallic zinc to strong hydrochloric or muriatic acid), sandpaper, emery cloth, and twine.

SUGGESTIONS.

The lists contained in this paper include many things that will not be required on a large number of farms. Where specialized farming is pursued, only the tools and supplies with which to repair the special farm equipment will be required. The indiscriminate purchase of tools may result in direct loss.

In deciding what tools and materials to purchase, always give preference to those most frequently and urgently needed, passing over those that will be rarely used.

Keeping a machine or vehicle in good repair and well oiled not only increases its efficiency, but lessens the power required in using it.

The proper maintenance of farm machines not only saves money but avoids danger to those who operate them. Keeping the harness and vehicles in repair may prevent a dangerous runaway.

So far as practicable let the repair work be done when regular farm work is not pressing, as on rainy days and during the winter season. Pursue the repair work as a kind of recreation or rest from the regular farm operations.

Do not have several places for the storage of repair tools and supplies. Have one convenient place, and see that all tools are kept there when not in use.

Tools and materials should be kept in their proper places. Do not keep all sizes of bolts or screws mixed together in a single receptacle, but fit up suitable boxes or bins, so that the supplies may be accessible on short notice.

Keep all tools clean and free from rust, and all edge tools sharp.

AN OPTICAL PROBLEM.

A RATHER curious problem relating to combinations is referred to by the British Journal of Photography. It is one that is not usually dealt with in textbooks, for probably no writer has foreseen that it could be one of practical interest. Yet for some reason or other it is one that is continually cropping up. Stated generally, the problem is as follows: A lens is fixed at a given distance from a screen, which is not at its focus. A sharp image is, however, to be produced by the interposition of a second lens of given focal length between the first lens and the screen. Where should this second lens be placed, and what is the focal length of the resulting combination? We know the focal lengths of the two lenses, but not their separation, and therefore querists generally fail to find the focal length. A little consideration should, however, show that the separation can easily be determined from the usual formulæ. The distance from the front lens to the screen is known, and this obviously is equal to the separation plus the back focus; that is, the distance from the second lens to screen. In this equation the separation is the only unknown quantity, and, therefore, its value is easily determined, after which the calculation of the focal length is a simple matter. To take an instance, suppose the front lens to be a 6-inch positive, and the back one a 6-inch negative, while the distance from front lens to screen is 14 inches. If a represents the separation, the application of the usual formulæ will show that the back focus

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is equal to $—6$. This added to $a = 14$, which equa-

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tion can be changed into $a^2 - 20a = -36$, and from this a must equal either 18 or 2. The former being impossible, 2 is the correct answer. The focal length can then be shown to be 18 inches.